

Cambridge International AS & A Level

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COMPUTER SCIENCE

9608/22

Paper 2 Fundamental Problem-solving and Programming Skills

October/November 2020

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer all questions.
- Use a black or dark blue pen.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do not write on any bar codes.
- You may use an HB pencil for any diagrams, graphs or rough working.
- Calculators must not be used in this paper.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [].
- No marks will be awarded for using brand names of software packages or hardware.

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			[4]
	Data type	Example data value	
	Complete the table by gi for each.	ving four different data types together with an example data	value
(c)	Programming languages	support different data types.	
			[2]
	State what a program de	signer represents using one or more of these methods.	
(b)	An algorithm may be doo a program flowchart, and	umented using different methods. These include structured En pseudocode.	glish,
	2		[1]
	Name the other stages.		
	One stage is INPUT.		
(a)	Algorithms usually consis	at of three different stages.	

(d) Draw lines to connect each of the following computing terms with the appropriate description.

Term	Description
Black-box testing	A structure for the temporary storage of data
File	A method used when the structure of the program is unknown
Assignment	A method of setting the value of a variable
Array	A structure for the permanent storage of data

(e) A pseudocode algorithm assigns values to three variables as follows:

 $\begin{array}{l} \texttt{FlagA} \leftarrow \texttt{TRUE} \\ \texttt{FlagB} \leftarrow \texttt{FALSE} \\ \texttt{FlagC} \leftarrow \texttt{TRUE} \end{array}$

Evaluate the expressions given in the following table:

Expression	Evaluates to
NOT FlagB AND FlagC	
NOT (FlagB OR FlagC)	
(FlagA AND FlagB) OR FlagC	
NOT (FlagA AND FlagB) OR NOT FlagC	

[2]

2 (a) The following pseudocode is an attempt to define an algorithm that takes two numbers as input and outputs the larger of the two numbers.

DECLARE	: A,	В:	INTEGER
INPUT A	7		
INPUT E	3		
IF A >	В		
THEN	I		
C	UTPU	TA	
ELSE	1		
	UTPU	T B	}
ENDIF			

The algorithm needs to be amended to include the following changes:

- 1. Input **three** values, ensuring that each value input is unique.
- 2. Output the average.
- 3. Output the largest value.

Write the pseudocode for the amended algorithm.

		[6]
(b)	Complete the pseudocode expressions in the following table.	
	Use only functions and operators described in the Appendix on pages	s 18–19.
	Expression	Evaluates to
	"ALARM: " & ("Time: 1202" ,)	"ALARM: 1202"
	("Stepwise." ,	"wise"
	1.5 * ("OnePointFive")	18
	(27.5)	"27.5"
	(9, 4)	2
		[5]
(c)	A problem may be decomposed into sub-tasks when designing an algo	rithm.
	Give three benefits of using sub-tasks.	
	1	
	2	
	3	
		[3]

3 A car has the ability to detect a skid by monitoring the rate of rotation (the rotational speed) of each wheel. If the rate of rotation of any wheel is not within 10% of the average of all four wheels, the car skids.

A function, CheckSkid(), is being developed.

The function will:

- simulate real-time data acquisition, by prompting for the input of four integer values in the range 0 to 1000 inclusive, representing the rate of rotation of each wheel
- calculate the average value
- check whether any individual value is more than 10% greater than the average or more than 10% less than the average
- return TRUE if any individual value is more than 10% greater than the average or more than 10% less than the average and FALSE otherwise

Visual Basic and Pascal: You should include the declaration statements for variables.

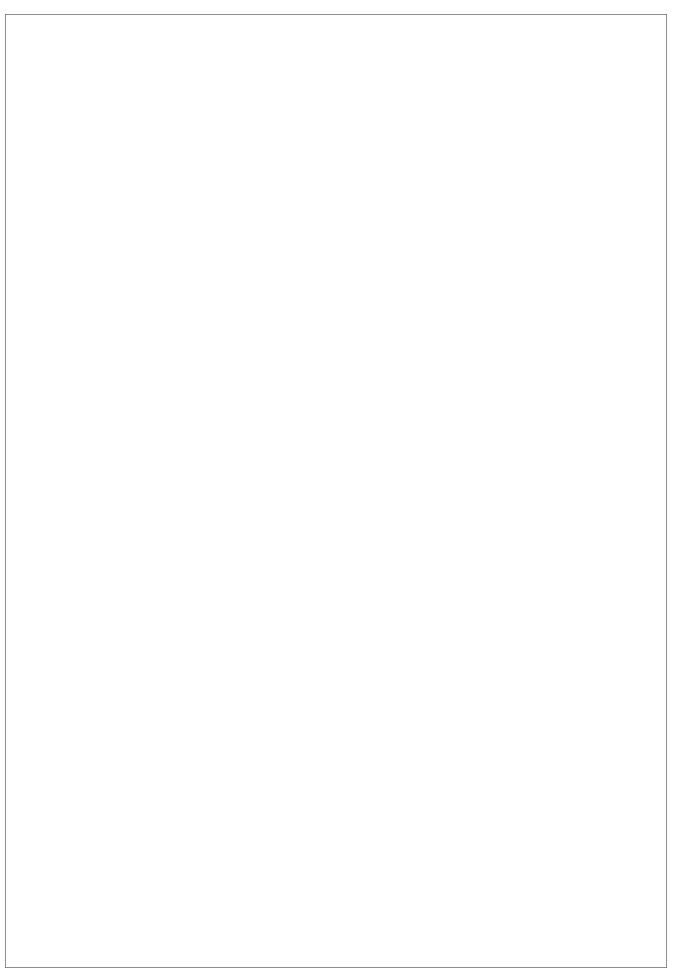
- output a suitable warning message.
- (a) Write program code for the function CheckSkid().

Python: You should show a comment statement for each variable used with its data type.
Programming language
Program code

					[8]
(b)	Give two sets of test	data that could be us	sed to test the functio	n.	
	Test 1 – No skid det	ected			
	Value1	Value2	Value3	Value4	
	Test 2 – Skid detect	ed			
	Value1	Value2	Value3	Value4	
					[2]

- **4 (a)** The following structured English describes an algorithm used to count the number of odd and even digits in an input sequence.
 - 1. Initialise variables OddCount and EvenCount to zero.
 - 2. Prompt and input an integer.
 - 3. If the integer is not in the range 0 to 9 then go to step 7.
 - 4. If the integer is an even number then add 1 to EvenCount.
 - 5. Otherwise add 1 to OddCount.
 - 6. Repeat from step 2.
 - 7. Output "Same" if there are the same number of odd and even integers.
 - 8. Output "Odd" if there are more odd than even integers.
 - 9. Output "Even" if there are more even than odd integers.

Draw a flowchart on the following page to represent the algorithm.



(b) The following pseudocode is an attempt to check whether two equal-length strings consist of identical characters.

Refer to the **Appendix** on pages 18–19 for the list of built-in functions and operators.

```
FUNCTION Compare (String1, String2: STRING) RETURNS BOOLEAN
   DECLARE x, y, Len1, Len2 : INTEGER
   DECLARE RetFlag : BOOLEAN
   DECLARE NextChar : CHAR
   DECLARE New : STRING
  Len1 ← LENGTH(String1)
  RetFlag ← TRUE
   FOR x \leftarrow 1 TO Len1
                                              // for each char in String1
     Len2 ← LENGTH(String2)
     NextChar \leftarrow MID(String1, x, 1)
                                              // get NextChar from String1
     New ← ""
     FOR y \leftarrow 1 TO Len2
                                              // for each char in String2
         IF NextChar <> MID(String2, y, 1) // no match
               New \leftarrow New & MID(String2, y, 1) // save this char from String2
         ENDIF
     ENDFOR
                                               // replace String2 with New
      String2 ← New
  ENDFOR
   IF LENGTH(String2) <> 0
                                               // anything left in String2 ?
      THEN
        RetFlag ← FALSE
   ENDIF
  RETURN RetFlag
```

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ENDFUNCTION

[5]

(i) Complete the trace table below by performing a dry run of the function when it is called as follows:

The first row has been completed for you.

String1	String2	Len1	RetFlag	x	Len2	NextChar	New	У
"SUB"	"BUS"	3	TRUE	1				

(ii)	State the value returned.	
		[1]

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(iii)	There is an error in the algorithm, which means that under certain circumstances, the function will return an incorrect value.
	Describe the problem. Give two test strings that would demonstrate it.
	Problem
	Test String1
	Test String2[2]
(iv)	Describe the modification that needs to be made to the algorithm to correct the error.
	Do not use pseudocode or program code in your answer.
	[1]
(v)	State the name given to the type of testing that makes use of a trace table.
(•)	[1]
	[.]
(vi)	State two features found in a typical Integrated Development Environment (IDE) that may be used for debugging a program.
	1
	2
	[2]

Question 5 begins on the next page.

5 A hashtag is used on a social media network. A hashtag is a string consisting of a hash character '#' followed by one or more alphanumeric characters.

A program is being developed to monitor the use of hashtags.

The program will include two global arrays each containing 10 000 elements:

- A 1D array, TagString, of type STRING stores each hashtag in a single element. All unused array elements contain an empty string ("").
- A 1D array, TagCount, of type INTEGER stores a count of the number of times each hashtag is used. The count value at a given index relates to the element stored at the corresponding index in the TagString array.

The contents of the two arrays will be stored in a text file Backup.txt. The format of each line of the file is:

```
<Hashtag><','><Count>
```

For example:

"#ComputerScienceClass,978"

A developer has started to define the modules as follows:

Module	Description
InitArrays()	Initialise the arrays
SaveArrays()	 The contents of the two arrays are stored in the text file Backup.txt Existing file contents will be overwritten Each hashtag and count are stored in one line of the file, as in the example above Unused TagString elements are not added to the file Returns the total number of unused TagString elements
LoadArrays()	 Values from the text file Backup.txt are stored in the two arrays The number of elements stored is returned

(a)	Write pseudocode for the module InitArrays().
	[4]

(c) Write program code for the module LoadArrays().

The module description is repeated here for reference.

Module	Description				
LoadArrays()	 Values from the text file Backup.txt are stored in the two arrays The number of elements stored is returned 				

You should assume:

- each line of the file contains a string of the correct format and no validation checks are required
- there are no more than 10 000 lines in the file.

Visual Basic and Pascal: You should include the declaration statements for variables. Python: You should show a comment statement for each variable used with its data type.

Programming language
Program code

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 	 	 	 	 	 [8]

Appendix

Built-in functions (pseudocode)

Each function returns an error if the function call is not properly formed.

LENGTH (ThisString: STRING) RETURNS INTEGER returns the integer value representing the length of string ThisString

Example: LENGTH ("Happy Days") returns 10

LEFT (ThisString : STRING, x : INTEGER) RETURNS STRING returns leftmost x characters from ThisString

Example: LEFT ("ABCDEFGH", 3) returns string "ABC"

RIGHT (ThisString: STRING, x : INTEGER) RETURNS STRING returns rightmost x characters from ThisString

Example: RIGHT ("ABCDEFGH", 3) returns string "FGH"

MOD (ThisNum: INTEGER, ThisDiv: INTEGER) RETURNS INTEGER returns the integer value representing the remainder when ThisNum is divided by ThisDiv

Example: MOD (10,3) returns 1

MID(ThisString : STRING, x : INTEGER, y : INTEGER) RETURNS STRING returns a string of length y starting at position x from ThisString

Example: MID ("ABCDEFGH", 2, 3) returns string "BCD"

DIV(ThisNum: INTEGER, ThisDiv: INTEGER) RETURNS INTEGER returns the integer value representing the whole number part of the result when ThisNum is divided by ThisDiv

Example: DIV(10,3) returns 3

NUM_TO_STRING(x : REAL) RETURNS STRING returns a string representation of a numeric value.

Note: This function will also work if x is of type INTEGER

Example: NUM TO STRING(87.5) returns "87.5"

STRING_TO_NUM(x : STRING) RETURNS REAL

returns a numeric representation of a string.

Note: This function will also work if x is of type CHAR

Example: STRING TO NUM("23.45") returns 23.45

Operators (pseudocode)

Operator	Description							
&	Concatenates (joins) two strings Example: "Summer" & " " & "Pudding" produces "Summer Pudding"							
AND	Performs a logical AND on two Boolean values Example: TRUE AND FALSE produces FALSE							
OR	Performs a logical OR on two Boolean values Example: TRUE OR FALSE produces TRUE							

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